

FILE

22.06

FINAL REPORT

Title: Distribution and abundance of breeding birds and small mammals in the high salt marsh and the adjacent upland critical edge in southern Maine, 1986.

Project Number: 53553-86-01

Refuge: Rachel Carson National Wildlife Refuge.

Investigators: John P. Lortie*, Biological Technician
Rachel Carson National Wildlife Refuge

Steven K. Pelletier, Wildlife Biologist
Rachel Carson National Wildlife Refuge
Volunteer

Date Submitted: 22 February 1988

* Current address: Woodlot Alternatives, P.O. Box 15431,
Portland, Maine 04101.

INTRODUCTION

Rachel Carson National Wildlife Refuge (NWR) is composed of nine estuaries that occur between Kittery and Cape Elizabeth, Maine (Figure 1). Each estuarine division contains a tidal river or stream, surrounding salt marsh, and adjacent upland. The marshes are predominantly New England irregularly flooded high salt marshes and regularly flooded low salt marshes (Cowardin et. al. 1979). These salt marsh communities are described in detail by Nixon (1982) and Teal (1986).

Intensive development pressure in southern Maine's coastal zone has consumed a large portion of the transitional riparian habitat (critical edge) surrounding salt marshes, and now threatens those remaining. Documentation of the values of these riparian zones to the salt marsh community and the species that use them is inadequate. Land use planners and resource managers need more accurate and quantitative information concerning bird and mammal distribution and abundance in these areas. This information will enhance their ability to make wise resource management decisions concerning riparian zone development.

The primary objective of this study was to document breeding bird and small mammal distribution and abundance in the high salt marsh and the adjacent riparian zone during the summer of 1986. A secondary objective was to explore preliminary riparian zone use guidelines that would enhance or at least maintain habitat for bird and mammal species found using these areas.

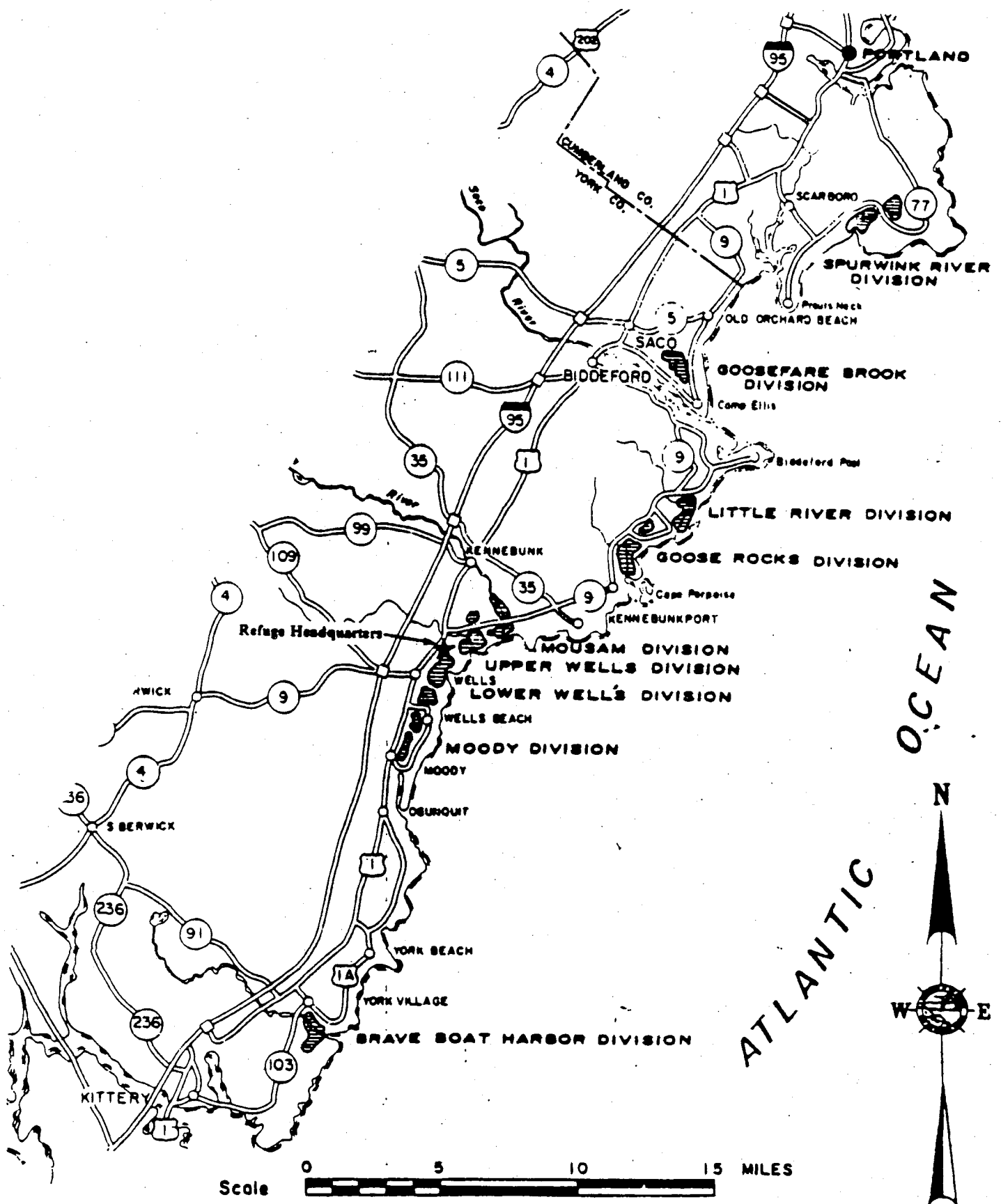
STUDY AREA

Ten study areas were selected on five salt marshes and their adjacent riparian zones in the towns of Kennebunkport, Kennebunk, Wells, York, and Kittery. All of these areas are part of Rachel Carson National Wildlife Refuge. Study sites were selected because of habitat type, accessibility, and proximity to disturbance. Disturbance included logging, building construction, residential housing, trailer parks, and roads.

The upland portions of two study sites, Goose Rocks-I and Upper Wells, contained an overstory of pitch pines (Pinus rigida), red maples (Acer rubrum), and red oaks (Quercus borealis). Understory vegetation was composed of dense thickets of serviceberry (Amelanchier canadensis), bayberry (Myrica pensylvanica), sweet gale (Myrica gale), high bush blueberry (Vaccinium corymbosum), male-berry (Lyonia ligustrina), and spirea (Spirea latifolia). These plots did not contain any disturbance within 100 m.

The upland portions of five study sites, Brave Boat-I, Brave Boat-II, Lower Landing Road, Moody-II, and Goose Rocks-II, contained a mixed overstory of white pine (Pinus strobus), red oak, and red maple. The understories contained thickets of speckled alder (Alnus rugosa), winterberry (Ilex veticillata),

Figure 1. Location of the nine divisions of Rachel Carson National Wildlife Refuge, southern Maine.



honeysuckle (Lonicera morrowi), sweet gale, spirea, poison ivy (Toxicodendron rydbergii), and Virginia rose (Rosa virginiana). The Goose Rocks-II, Upper Landing Road, and Moody II plots appeared to have been logged approximately fifty years ago. The Brave Boat plots contained a number of white pines and red oaks with a diameter at breast height (dbh) greater than twelve inches, indicating that the stands had not been cut for some time.

The Brave Boat-I and II plots were over 100 m away from any disturbance. The Lower Landing Road and Moody-II plots both contained some disturbance. The Goose Rocks-II site had a road directly abutting the southern plot boundary.

The upland portion of three study sites, Mile Road, Moody - I, and Upper Landing Road, were dominated by thickets of speckled alder, arrow-wood (Viburnum dentatum), honeysuckle, winterberry, spirea, and serviceberry. No overstory existed, but the areas appeared to have supported stands of red maple and white pine within the past thirty years, based on the presence of old stumps. Both the Mile Road and Upper Landing Road plots contained disturbance from condominium construction. Construction activities varied from 40m to 150m away from the study plots. The northern end of the Moody - I plot was adjacent to a secondary road. The rest of this plot was undisturbed.

The high salt marsh community in all study plots was characterized by a mixture of Spartina patens, S. pectinata, Distichlis spicata, Triglochin maritima, Panicum virgatum, and several other less common species. All of these salt marshes were ditched in the nineteen thirties as part of a mosquito control program and most plots contained some ditching. Salt pannes, small flooded pools, were distributed throughout the study plots. These pannes varied from ones that normally dry up in late summer, to pannes that contained more than 30 cm of water in them throughout the year. The deeper pannes supported populations of striped killifish (Fundulus majalis) and four-spined sticklebacks (Apeltes quadracus).

BREEDING BIRD DISTRIBUTION AND ABUNDANCE

ABSTRACT

Breeding birds were distributed throughout forested portions of all plots and sporadically distributed in the salt marsh. Unvegetated areas did not contain any nesting species except for a single pair of killdeer (Charadrius vociferus). In two pitch pine (Pinus rigida) sample plots, breeding bird abundance ranged from 15 to 17 singing males per five hectares. In five mixed forest plots breeding bird abundance ranged from 10 to 42 singing males per five hectares. In three shrub forest plots, breeding bird abundance ranged from 20 to 27 singing males per five hectares. Thirty-seven bird species were observed nesting or attempting to nest within the study plots. Birds that are

permanent Maine residents or that migrate only to the southern United States, were the most abundant and widely distributed species found.

METHODS

Plot Establishment

Ten 5 ha plots, 100 m by 500 m, were located along the high salt marsh/upland edge in three common habitat types; pitch pine forest, mixed forest, and shrub forest (see appendix for plot locations). Each plot extended 50 m into the salt marsh, 50 m into the upland, and paralleled the edge for 500 m. Within each plot a 30 m grid pattern was established throughout, using wire flag markers and surveying tape. Each grid point was given a letter/number designation that corresponded to field data forms (appendix). Techniques for establishing plots followed methods suggested by Stamp (1978).

Four plots were located so that there was no disturbance within 100 m, two were located 50 - 100 m from disturbance, and four contained or were directly adjacent to disturbance. Disturbance included roads, residential housing, condominiums, motels, restaurants, and tenting/trailer parks.

Vegetation Sampling

Each 5 ha plot was subdivided into three parallel zones 33.3 m wide for vegetation analysis, these were the salt marsh zone, transition zone, and upland zone. Vegetation sampling in each zone occurred on randomly selected grid points. Transition zone and upland zone sampling techniques were adapted from James and Shugart (1970) and Stamp (1978).

In the salt marsh three 0.02 ha plots were examined and the following parameters were recorded: number of plant species, percent ground covered by each plant species, percent open water, percent salt panne, percent ditched creek, percent dike, and percent debris.

In the transition zone four 0.04 ha plots were sampled. The above parameters as well as the percentage of the plot that was salt marsh were recorded. Tree species were recorded and placed in one of nine size classes ranging from 0 cm to greater than 30 cm dbh. Alnus rugosa less than 3.8 cm dbh was recorded in shrub density measurements.

Shrub density was estimated by sampling 0.008 ha within each subplot by counting the number of shrub stems intersecting outstretched arms along two transect lines. Shrub transect lines of 22.6 m in length were oriented in the cardinal directions, intersected at the sub-plot center, and ran from one end of the plot to the other. Along each of these lines percent canopy cover and percent ground cover were estimated at ten evenly

spaced points using an ocular tube. At each point the presence or absence of vegetation in four height zones, 0.0 - 0.5 m, 0.6 - 3.0 m, 3.1 - 10.0 m, and > 10.0 m was recorded. On each plot the minimum, maximum, and average canopy heights were estimated, using a Merritt hypsometer, and recorded.

Tree density, coniferous tree density, density of trees > 30.5 cm, basal area, mean tree diameter, foliage profiles, and snag density were calculated using collected vegetation data.

Bird Censusing

Birds were censused by spot-mapping (Robbins 1970, Eagles 1981) singing males, song posts, females with and without nesting materials, juveniles, and nests. Plots were examined once a week from 25 May to 18 July, beginning one-half hour before sunrise and ending no later than 1000 hours. Observers walked along plot transect lines and recorded bird observations on maps. Starting locations were changed weekly to avoid temporal biases (Davis 1965, Eagles 1981). Bird behavior, such as territorial defense, was recorded on field sheets. Efforts were made to not include repeat sightings of an individual without indicating that factor. One censuser randomly field checked all plots during June and July to minimize and correct for observer bias.

Composite maps for each species were made from field data forms. A species was considered to be holding territory when a minimum of three valid registrations were recorded during different censuses. Locations of territories in salt marsh, transition, or upland habitat were determined from composite maps and field data. Density estimates were used to calculate Bird Species Diversity (BSD) and evenness (Brower and Zar 1977, Pielou 1966).

RESULTS AND DISCUSSION

Vegetation Sampling

The upland extent of the salt marsh zone ended where woody shrubs and Panicum virgatum grew. The most abundant plant species in the salt marsh zone of each plot were Spartina patens and Spartina alterniflora. Overall they accounted for 37% and 29%, respectively, of the vegetated ground cover in the study plots. S. alterniflora typically grew in the short form in the areas sampled. Distichlis spicata (7%), Agrostis alba (3%), Juncus gerardi (3%), and Suaeda maritima (3%) were next in overall abundance. Additional common plants within the plots were Juncus balticus, Atriplex patula, Plantago maritima, and Solidago sempervirens. Uncommon plants within the salt marsh zone included; Scirpus olneyi, S. robustus, Atriplex arenaria, Salicornia spp., Suaeda linearis, Potentilla norvegica, Glaux maritima, and Aster subulatus.

Seventy-seven percent of the salt marsh habitat sampled was vegetated, 14% was unvegetated salt panne, 5% was open water, and

4% was ditched creek.

Upland portions of the study plots were characterized by a diversity of plant species composition and abundance (Tables 1 and 2). Transitional habitats between wetlands and uplands are typically diverse due to changes in physical and chemical parameters within the soil. Such things as salinity, hydrology, and nutrient availability can change drastically with narrow changes in elevation. This can result in abrupt changes in plant species composition and abundance.

Breeding Birds

Pitch Pine Forest

Densities of breeding birds in the pitch pine forest plots were 15 and 17 males/5 ha (Table 3). Common yellowthroats, song sparrows, and American goldfinches were the most abundant species in this habitat type (Table 4). They accounted for sixty percent of the breeding birds. Breeding birds were distributed throughout these study plots in areas with woody vegetation.

Song sparrows (n=8) nested directly along the salt marsh/upland ecotone. In these plots, 1 nest was located on the ground under a dense tuft of Spartina patens. Four other general nest locations were found when birds believed to be incubating flushed from the nest. All of these nests were located in dense herbaceous growth (Panicum virgatum, Spartina pectinata, Spartina patens) within 5 m of the high salt marsh/upland edge.

Common yellowthroats (n=8) primarily nested within 10 m of the salt marsh in dense shrubs including Myrica pensylvanica, M. gale, Spirea latifolia, Toxicodendron rydbergii, and Amelanchier canadensis. American goldfinches (n=3) nested in similar habitat and in smaller groups of sapling Acer rubrum and Amelanchier canadensis.

Mixed Forest

Densities of breeding birds in the mixed forest ranged from 10 to 42 males/5 ha (Table 3). Common yellowthroats, red-winged blackbirds, yellow warblers, and song sparrows were the most abundant species (Table 4). They accounted for thirty-four percent of the breeding birds. Breeding bird territories were found in disturbed and undisturbed portions of plots. Generally the number of breeding bird territories decreased as the amount of available nesting habitat decreased.

Red-winged blackbird (n=10) territories were sporadically distributed throughout the plots. Territories extended up to 15 m into the salt marsh where herbaceous vegetation greater than 0.5 m was present. Territories extended 50 m into upland areas where shrubs were dominant. Major plant species in red-winged blackbird territories included Typha angustifolia, Spartina

Table 1. Vegetational characteristics in the transition zone of each plot.

Habitat	Plot	Name	Deciduous	Coniferous	Tree	Mean	Shrub	Snag	Shrub	Foliage	Percent	Percent	Percent	Mean
Type	Name	Tree	Density	Density	Basal	Tree	Density	Diameter	Density	Height	Ground	Canopy	Canopy	Height
			#/ha	#/ha	m ² /ha	cm	#/ha	#/ha	#/ha		Cover	Cover	Cover	m
Pitch	GR-I		520	125	10	9	12	6,100	1.6	89	8	3.1		
Pine														
Forest	UW		325	180	15	15	95	29,525	1.8	62	3	1.6		
Mixed	BBH-I		712	145	25	6	20	4,850	2.0	82	43	8.9		
Forest	BBH-II		275	112	8	9	30	2,475	2.1	87	17	8.1		
	LLR		1,195	70	22	5	30	24,688	1.9	42	31	5.8		
	GR-II		1,238	188	40	10	62	14,525	2.1	56	50	6.6		
	M-II		428	20	28	8	12	26,725	1.9	51	43	6.6		
Shrub	MR		745	0	8	6	0	15,625	2.0	94	6	3.9		
Thickets	ULR		95	0	2	10	0	4,775	1.9	92	4	0.8		
	M-I		200	31	2	4	0	23,750	1.6	96	2	0.4		

Plot Names: GR-I = Goose Rocks-I, UW = Upper Wells, BBH-I = Brave Boat Harbor-I, BBH-II = Brave Boat Harbor-II, LLR = Lower Landing Road, GR-II = Goose Rocks-II, M-II = Moody-II, MR = Mile Road, ULR = Upper Landing Road, and M-I = Moody-I.

Table 2. Vegetational characteristics in the upland zone of each plot.

Habitat	Plot	Name	Deciduous	Coniferous	Tree	Mean	Basal	Tree	Snag	Shrub	Foliage	Percent	Percent	Percent	Mean
Type			Density	Density	Density	Tree	Area	Diameter	Density	Density	Height	Ground	Canopy	Canopy	Height
			#/ha	#/ha	#/ha	cm	m ² /ha	cm	#/ha	#/ha	#/ha	Cover	Cover	Cover	m
Pitch	GR-I	1,330	750	45	9	20	25,625	2.2	54	48	5.4				
Pine	UW	855	525	52	11	138	41,100	2.2	63	43	4.6				
Mixed	BBH-I	1,238	345	80	11	220	7,350	2.2	28	74	16.0				
Forest	BBH-II	1,680	438	85	10	175	4,350	2.7	17	81	17.0				
	LLR	330	0	2	5	0	12,025	2.0	95	5	0.8				
	GR-II	212	12	7	5	5	2,500	1.5	87	39	3.9				
	M-II	170	0	2	8	0	12,025	1.8	90	2	1.2				
Shrub	MR	1,080	0	15	6	0	25,625	2.2	92	20	3.9				
Thickets	ULR	2,380	0	32	6	5	23,688	1.1	20	34	3.1				
	M-I	1,500	62	35	6	30	50,000	2.8	58	46	8.1				

Plot Names: GR-I = Goose Rocks-I, UW = Upper Wells, BBH-I = Brave Boat Harbor-I, BBH-II = Brave Boat Harbor-II, LLR = Lower Landing Road, GR-II = Goose Rocks-II, M-II = Moody-II, ULR = Upper Landing Road, and M-I = Moody-I.

Table 3. Breeding bird species diversity, richness, evenness and density (# males/5 ha) in three types of salt marsh/upland edge habitats in southern Maine, 1986.

Habitat Type	Plot Location	Bird Species Diversity H'	Richness	Evenness	Density of Breeding Birds # males/5 ha
Pitch Pine Forest	GR-I	0.94	10	0.80	15
	UW	0.78	8	0.63	17
Mixed Forest	BBH-I	1.03	12	0.79	20
	BBH-II	0.94	9	0.94	10
	LLR	1.26	22	0.78	42
	GR-II	1.19	17	0.86	24
	M-II	1.07	15	0.74	28
Shrub Thickets	MR	1.02	12	0.71	27
	ULR	0.81	8	0.62	20
	M-I	1.01	12	0.75	22

Plot Locations: GR-I = Goose Rocks-I, UW = Upper Wells, BBH-I = Brave Boat Harbor-I, BBH-II = Brave Boat Harbor-II, LLR = Lower Landing Road, GR-II = Goose Rocks-II, M-II = Moody-II, MR = Mile Road, ULR = Upper Landing Road, and M-I = Moody-I.

Bird Species Diversity, H' = Shannon's function (Brower and Zar 1977).

Evenness = Evenness of the distribution of each individual among the species (Brower and Zar 1977).

Table 4. Breeding bird occurrence and density (# males/5 ha) per plot.

Species	Habitat Type and Plot Names									
	Pitch	Mixed Forest	Shrub	Pine	Forest	GR-I	UW	BBH-I	BBH-II	LLR
American black duck	1									
Green-backed heron										
Killdeer										
Willow										
Northern flicker										
Downy woodpecker										
Hairy woodpecker										
Eastern kingbird										
Great crested flycatcher										
Eastern wood-pewee										
Willow flycatcher										
Purple martin										
Tree swallow										
American crow										
Blue jay										
Black-capped chickadee										
Tufted titmouse										
White-breasted nuthatch										
Gray catbird										
American robin										
Cedar waxwing										
Black-and-white warbler										
Chestnut-sided warbler										
Yellow warbler										
Common yellowthroat										
Ovenbird										
Red-winged blackbird										
Common grackle										
European starling										
Northern oriole										
Northern cardinal										
House finch										
American goldfinch										
Rufous-sided towhee										
Song sparrow										
White-throated sparrow										
Sharp-tailed sparrow										

GR-I = Goose Rocks-I, UW = Upper Wells, BBH-I = Brave Boat Harbor-I, BBH-II = Brave Boat Harbor-II, LLR = Lower Landing Road, GR-II = Goose Rocks-II, M-II = Moody-II, MR = Mile Road, ULR = Upper Landing Road, and M-I = Moody-I.

pectinata, Scirpus americanus, Ilex verticillata, and Rosa virginiana.

Song sparrow territories (n=9) were distributed directly along the salt marsh/upland edge. Territories extended up to 30 m into the upland in partially cleared areas. Territories extended 15 m into the salt marsh where pockets of vegetation (Myrica pensylvanica and Scirpus americanus) greater than 1 m in height existed.

Ovenbirds are ground nesters and prefer mature stands with relatively little understory (Terres 1982). Ovenbird territories (n=5) were in the interior portions of the upland half of each plot. They were usually 30 m from the salt marsh edge. Dominant shrub species in their territories included Gaylussacia baccata, Vaccinium corymbosum, and Myrica pensylvanica.

Black-capped chickadees (n=4), tufted titmice (n=3) and great crested flycatchers (n=3) are all cavity nesters. Black-capped chickadee nests (n=2) were found in dead Betula alba trees approximately 10 m and 40 m from the salt marsh edge. One tufted titmouse nest was found in a living Quercus borealis, which was 15 m from the salt marsh edge. No great crested flycatcher nests were found. These birds establish large territories (Bent 1942), which made nest site difficult to locate. Suitable cavity nesting trees in the understory not already mentioned include Acer rubrum, Prunus serotina, and Fagus grandifolia.

Shrub Thickets

Densities of breeding birds in the shrub thickets ranged from 20 to 27 males/5 ha (Table 3). Common yellowthroats, red-winged blackbirds, yellow warblers, and song sparrows were the most abundant species (Table 4). They accounted for fifty-five percent of the breeding birds. Breeding bird territories were generally found in the undisturbed portions of the plots. One pair of killdeer successfully nested in a bulldozed area. Construction activities directly adjacent to these plots did not discourage the above mentioned species from attempting to nest.

Red-winged blackbirds (n=10) defended territories throughout the vegetated upland portions of all plots. Some territories extended 15 m into the salt marsh, usually where marsh vegetation was dense and greater than 0.5 m in height. Red-winged blackbirds were absent from bulldozed upland areas cleared of almost all vegetation. Dominant plant species in nesting territories included Spirea latifolia, Ilex verticillata, Alnus rugosa, and Rosa virginiana.

Song sparrow (n=8) territories were located directly along the salt marsh/upland ecotone. Territories extended into cleared areas but not more than 5 m into forested areas. Dominant vegetation included Spartina pectinata, Spartina patens, Panicum virgatum, and Spirea latifolia.

General Comments

Some of the plots sampled were portions of larger unfragmented forest communities, while others were narrow strips of remanent forest or new shrub forest. The influence of forest fragmentation on many neotropical songbirds breeding in the northeast and wintering in the tropics has been discussed by Robbins (1979). He found many of these species to be disappearing from localities where forests were becoming fragmented, while on the other hand, short distance migrants and permanent residents were maintaining their populations. Our plots contained some species Robbins (1979) mentions as having adapted to survival in edge habitats including catbirds, robins, starlings, and rufous-sided towhees. These and other "characteristic edge species", primarily short distance migrants, were the most abundant and widely distributed birds throughout the study plots.

A total of 75 bird species were observed in the study plots during censuses, of these 37 species were believed to be breeders. The most interesting breeders found were willow flycatchers. Three different males held territories in one plot. This species was only recently confirmed as a nester in Maine (Adamus et. al. 1987). Additional species of interest were willets, green-backed herons, black ducks, purple martins, northern orioles, and sharp-tailed sparrows.

Habitat alteration in the plots resulted in a decrease in the structural diversity of the vegetation. Habitat selection by passerines is most strongly influenced by the structure of the vegetation (Noon et. al. 1979). Obviously parking lots, bulldozed areas and lawns, with a very low structural diversity, do not meet the habitat requirements for most bird species found nesting along the riparian edge. Killdeer were the only species we found to be the exception to this general rule.

In our study plots we found that breeding birds used available vegetated forest, shrubs, and tall herbaceous growth for nesting, even when it was only 15 m wide. However, the species we found in these situations are widespread and very common throughout the northeastern United States. These narrow strips may not provide habitat for species with large territories like cooper's hawks, goshawks, great horned owls or other raptors.

SMALL MAMMAL DISTRIBUTION AND ABUNDANCE

ABSTRACT

The distribution and abundance of small mammals in irregularly flooded salt marsh and the adjacent upland edge was examined in 1986. Ten 100 m by 100 m plots were sampled in five salt marshes in York County, Maine. Small mammals were collected with wooden snap traps and metal pit traps (# ten cans) between 21 July and

22 August 1986. Eleven species were captured including 3 Microtus pinetorum, the first state records for this mammal. Densities ranged from 1.8 to 10.0 small mammals captured per 100 trap nights. Species richness ranged from 3 to 7 species per plot. Peromyscus leucopus accounted for 50 percent of all captures.

METHODS

Plot Establishment

Small mammal plots were located within breeding bird study plots mentioned earlier in this paper. Small mammals were collected on each plot with wooden snap traps and metal pit traps (# 10 cans) set in parallel lines of ten stations each, with three mousetraps and one pit trap per station. Lines were located so that half of the stations were in upland habitat and half were in salt marsh habitat (see appendix for diagram). On each plot, one set of lines ran perpendicular to the salt marsh/upland edge, and one set ran parallel to the edge. Sampling guidelines followed techniques suggested by G. Clough (personal communication).

Small Mammal Censusing

Each plot was sampled for five consecutive nights between 21 July and 22 August. Standard peanut butter was used as an attractant on the snap traps. Small mammal capture locations and dates were recorded each day as traps were checked. Capture location records provided data for species abundance and distribution in relation to salt marsh, edge, and upland habitat. Plot vegetational characteristics provided data on edge and upland habitat types.

RESULTS AND DISCUSSION

Eighty-one percent of all small mammals were caught in upland habitat, and nineteen percent were captured in the salt marsh. Meadow jumping mice (Zapus hudsonius), white-footed mice (Peromyscus leucopus), and meadow voles (Microtus pennsylvanicus) accounted for eighty percent (n = 47) of small mammals caught in the salt marsh.

White-footed mice accounted for fifty percent of all small mammal captures followed by shorttail shrews (Blarina brevicauda) (11%), masked shrews (Sorex cinereus) (10%), meadow jumping mice (8%), meadow voles (8%), red-backed voles (Clethrionomys gapperi) (6%), Eastern chipmunks (Tamias striatus) (3%), star-nose moles (Condylura cristata) (1%), pine voles (Microtus pinetorum) (1%), house mice (Mus musculus) (1%), and a smokey shrew (Sorex fumeus) (1%). Sixty-four percent of all small mammals were caught in snap traps, while thirty-six percent were caught in pit traps.

Pitch Pine Forest

In 1,323 trap nights (TN), 91 small mammals (SM) made up of 9 species were caught: 31% of all captures were white-footed mice, 22% were masked shrews, 21% were meadow jumping mice, and 19% were red-backed voles. Five other species combined, composed 7% of all captures (Table 5).

Capture rates were 3.4 SM per 100 TN in the Goose Rocks-I plot and 10.0 SM per 100 TN in the Upper Wells plot (Table 6). Seventy percent of all captures occurred in the upland. Twenty-seven SM were caught in the salt marsh including 14 meadow jumping mice, 6 white-footed mice, 5 masked shrews, 1 red-backed vole, and 1 meadow vole.

Dominant vegetation in the upland included Myrica pensylvanica, Gaylussacia baccata, Vaccinium corymbosum, Amelanchier canadensis, Pinus rigida and Acer rubrum (Table 2).

Mixed Forest

In 3,051 TN, 137 SM made up of 9 species were caught; 61 % of all captures were white-footed mice and 16% were shorttail shrews. Seven other species combined, composed 23% of all captures (Table 5). Total capture rates ranged from 1.8 SM per 100 TN to 8.2 SM per 100 TN (Table 6).

Eighty-three percent of all captures occurred in upland habitat. Twenty-three small mammals were caught in the salt marsh including 9 meadow voles, 7 white-footed mice, 2 shorttail shrews, 1 meadow jumping mouse, and 1 pine vole. Dominant upland vegetation in these study areas included Pinus strobus, Quercus borealis, Acer rubrum, Gaylussacia baccata, Vaccinium corymbosum, and Myrica pensylvanica.

Shrub Thickets

In 2,012 TN, 79 SM made up of 9 species were caught; 58% of all captures were white-footed mice and 13% were shorttail shrews. Seven other species combined accounted for 29% of all captures (Table 5). Total capture rates ranged from 2.8 SM per 100 TN to 5.1 SM per 100 TN (Table 6).

Eighty-nine percent of all captures occurred in upland habitat. Nine small mammals were caught in the salt marsh including 5 white-footed mice, 2 shorttail shrews, and 2 meadow voles. Dominant upland vegetation in these study areas included Acer rubrum, Spirea latifolia, Ilex verticillata, Alnus rugosa, and Rosa virginiana.

Table 5. Mammal occurrence and density (percentage of total caught) per plot.

Species	Habitat Type and Plot Names									
	GR-I	UM	BBH-I	BBH-II	LLR	GR-II	M-II	MR	ULR	M-I
<i>Sorex cinereus</i>	43	16	.	18	11					15
<i>Sorex fumeus</i>		5								
<i>Blarina brevicauda</i>		7	12	35		21	15	31		
<i>Conylura cristata</i>								12		
<i>Tamias striatus</i>	3	3		9		11		6		
<i>Zapus hudsonius</i>		27		12			5	9		
<i>Peromyscus leucopus</i>	33	30	90	71	41	46	39	65	33	73
<i>Clethrionomys gapperi</i>	14	20		2						8
<i>Microtus pennsylvanicus</i>		3	10	12	27	18	5	9	4	
<i>Microtus pinetorum</i>		5								
<i>Mus musculus</i>		1								10

Plot Names: GR-I = Goose Rocks-I, UM = Upper Wells, BBH-I = Brave Boat Harbor-I, BBH-II = Brave Boat Harbor-II, LLR = Lower Landing Road, GR-II = Goose Rocks-II, M-II = Moody-II, MR = Mille Road, ULR = Upper Landing Road, and M-I = Moody-I.

Table 6. Small mammal species diversity, richness and evenness in three types of salt marsh/upland edge habitats in southern Maine, 1986.

Habitat Type	Plot Location	MSD ^a	Richness	Evenness	N ^b
Pitch Pine Forest	GR-I	0.44	5	0.63	3.4
	UW	0.69	7	0.82	10.0
Mixed Forest	BBH-I	0.17	3	0.36	6.1
	BBH-II	0.41	5	0.59	8.2
	LLR	0.54	4	0.90	2.3
	GR-II	0.54	4	0.90	1.8
	M-II	0.64	5	0.92	5.3
Shrub	MR	0.48	5	0.69	2.8
	ULR	0.69	6	0.89	5.1
	M-I	0.29	4	0.48	3.9

Plot Locations: GR-I = Goose Rocks-I, UW = Upper Wells, BBH-I = Brave Boat Harbor-I, BBH-II = Brave Boat Harbor-II, LLR = Lower Landing Road, GR-II = Goose Rocks-II, M-II = Moody-II, MR = Mile Road, ULR = Upper Landing Road, and M-I = Moody-I.

a - MSD = mammal species diversity based on Shannon's function (Brower and Zar 1977).

b - N = number of small mammals captured per 100 trap nights.

Evenness = Evenness of the distribution of each individual among the species (Brower and Zar 1977).

General Comments

Small mammal species diversity and richness varied considerably between some plots but not in others (Table 6). Species richness was greatest (n=7) in the Upper Wells plot, a pitch pine forest, and was lowest (n=3) in the Brave Boat Harbor-I plot, a mixed forest plot. Mammal species diversity was also lowest in this plot, with white-footed mice accounting for 90% (n=26) of all captures. No apparent reasons for these large differences in mammals species diversity and richness were observed. Factors such as local population abundance, predation pressures, susceptibility to trapping, weather conditions and natural food supply could have affected trapping success.

White-footed mice were the most abundant small mammals in nine of ten trapping sites, they accounted for fifty percent of all captures. In the site that they were not the most abundant species, they still accounted for 33% of all captures. Small (1986) reported that this species was one of the most abundant small mammals captured along an estuarine river edge in central Maine.

Uncommon small mammals captured included 4 star-nosed moles, 3 pine voles, 3 house mice, and 1 smokey shrew. Collectively these species accounted for less than 4% of all small mammal captures. The smokey shrew was captured in a pitch pine forest (Goose Rocks-I site). Godin (1977) reports that this shrew is essentially a northern and mountain species preferring damp woods and bogs. Therefore it is surprising we captured any at all.

The pine voles were captured at the Goose Rocks I (n=1) site and at the Brave Boat Harbor-II (n=2) site. These records represent the first state records for the pine vole in Maine. However, this vole occurs in several New Hampshire locations and Clough (1984) predicted it was only a matter of time before it was found in York County.

A number of large mammals were seen or their tracks or scats were observed in and around the study plots. These included coyotes (Canis latrans), red fox (Vulpes vulpes), raccoons (Procyon lotor), striped skunks (Mephitis mephitis nigra), river otters (Lutra canadensis), and whitetail deer (Odocoileus virginicus). In addition to these, domestic cats and dogs were observed hunting in and out of the study plots on several occasions. The effects of domestic pets should be further investigated because we frequently observed them hunting in the marsh and upland edge in plots next to developed areas. However, we did not collect any quantitative information.

Literature Cited

- Adamus, P.R. 1987. Atlas of breeding birds in Maine, 1978-1983. Published by Maine Endangered and Nongame Wildlife Fund, Maine Department of Inland Fisheries and Wildlife, Augusta, Maine.
- Bent, A.C. 1942. Life histories of North American flycatchers, larks, swallows, and their allies. U.S. National Museum Bulletin, Number 179, Washington, D.C.
- Brower, J.E. and J.H. Zar. 1977. Field and laboratory methods for general ecology. Wm. C. Brown Company, Dubuque, Iowa.
- Clough, G.C. 1984. Voles and lemmings: The furry scurriers. Maine Fish and Wildlife - Summer 1984.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service Biological Services Program FWS/OBS-79/31.
- Davis, J. 1965. The "singing male" method of censusing birds: a warning. Condor 67: 86-87.
- Eagles, P.F.J. 1981. Breeding bird censuses using spot-mapping techniques upon samples of homogenous habitats. Pages 455-460 In C.J. Ralph and J.M. Scott (eds.). Estimating the numbers of terrestrial birds. Studies in Avian Biology Number 6. Cooper Ornithological Society.
- Godin, A.J. 1977. Wild mammals of New England. The John Hopkins University Press, Baltimore and London.
- James, F.C. and H.H. Shugart, Jr. 1970. A quantitative method of habitat description. Audubon Field Notes 24: 727-736.
- Nixon, S.W. 1982. The ecology of New England high salt marshes: a community profile. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-81/55.
- Noon, B.R., V.P. Bingham, and J.P. Noon. 1979. The effects of changes in habitat on northern hardwood forest bird communities. Pages 33-48 In R.M. DeGraaf and K.E. Evans (eds.). Workshop Proceedings: Management of north central and northeastern forests for nongame birds. U.S. Forest Service General Technical Report NC-51.
- Pielou, E.C. 1966. The measurement of diversity in different types of biological collections. Journal of Theoretical Biology 13: 131-144.
- Robbins, C.S. 1970. Recommendations for an international standard for a mapping method in bird census work. Audubon Field Notes 24: 723-726.

Robbins, C.S. 1979. Effects of forest fragmentation on bird populations. Pages 198-212 In R.M. DeGraaf and K.E. Evans (eds.). Workshop Proceedings: Management of north central and northeastern forests for nongame birds. U.S. Forest Service General Technical Report NC-51.

Small, M.F. 1986. Response of songbirds and small mammals to powerline and river edges of Maine oak-pine forests. M.S. Thesis, University of Maine at Orono.

Stamp, N.E. 1978. Breeding birds of riparian woodland in south-central Arizona. Condor 88:64.

Terres, J.K. 1982. The Audubon Society Encyclopedia of North American Birds. Alfred A. Knopf, New York.

Teal, J.M. 1986. The ecology of regularly flooded salt marshes of New England: a community profile. U.S. Fish and Wildlife Service Biological Report 85(7.4).

ACKNOWLEDGEMENTS

This study would not have been possible without the incredible efforts of Carollee Ferris, who regularly went above and beyond the call of duty. Mark Turner provided us with exemplary efforts and Ellie Clark, Fanny Dale, Art Garland, William Hamilton, Susan Hamilton, Meg Hutchins and Nancy McReel all provided an extraordinary effort. Bob Dalrymple and Gennie Decker provided much needed assistance during the early phases of the project. Special thanks is also due to Andrew French who helped guide the project throughout its entirety. We are indebted to the following people who helped review drafts of this report, Ralph Andrews, Jack Witham, Jody Jones, Mac Hunter, Gerry Atwell, Steve Meyer, and Cathy Elliott.

APPENDIX

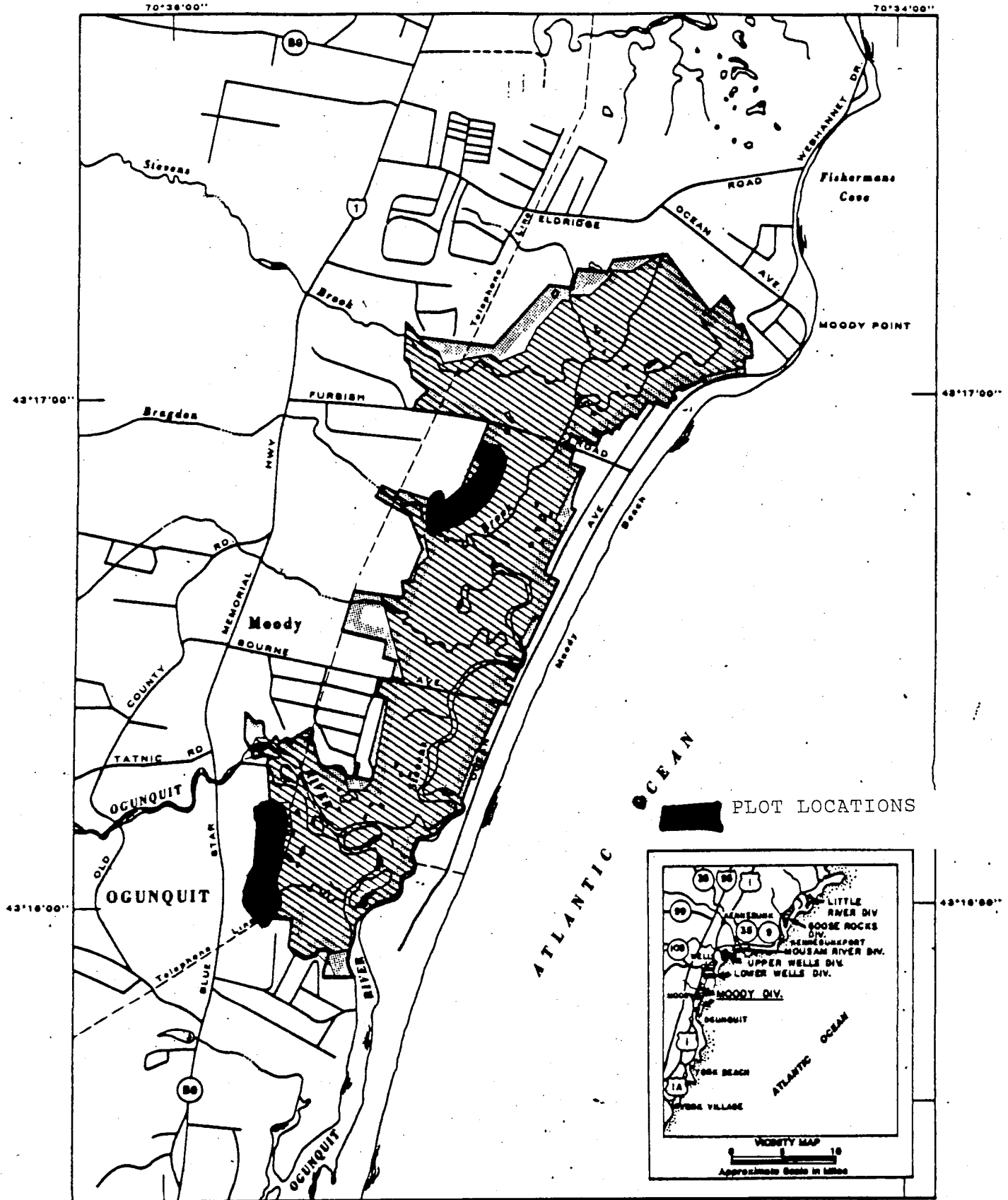
RACHEL CARSON NATIONAL WILDLIFE REFUGE

MOODY
DIVISION

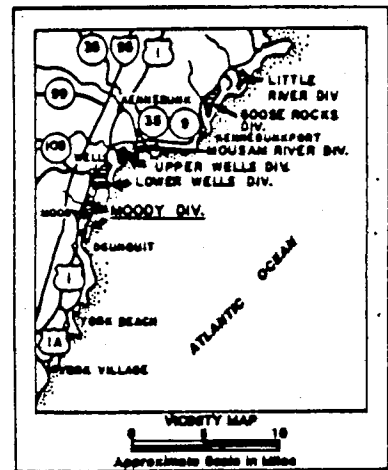
UNITED STATES
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

UNITED STATES
FISH AND WILDLIFE SERVICE



PLOT LOCATIONS



70°36'00"
COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G.S. AND U.S.F.A.W.S.

NEWTON CORNER, MASSACHUSETTS 1966

0 800 1600 2400 3200 FEET
0 4 8 KILOMETERS

70°34'00"
17°20' 16°30'
MEAN
DECLINATION
1978

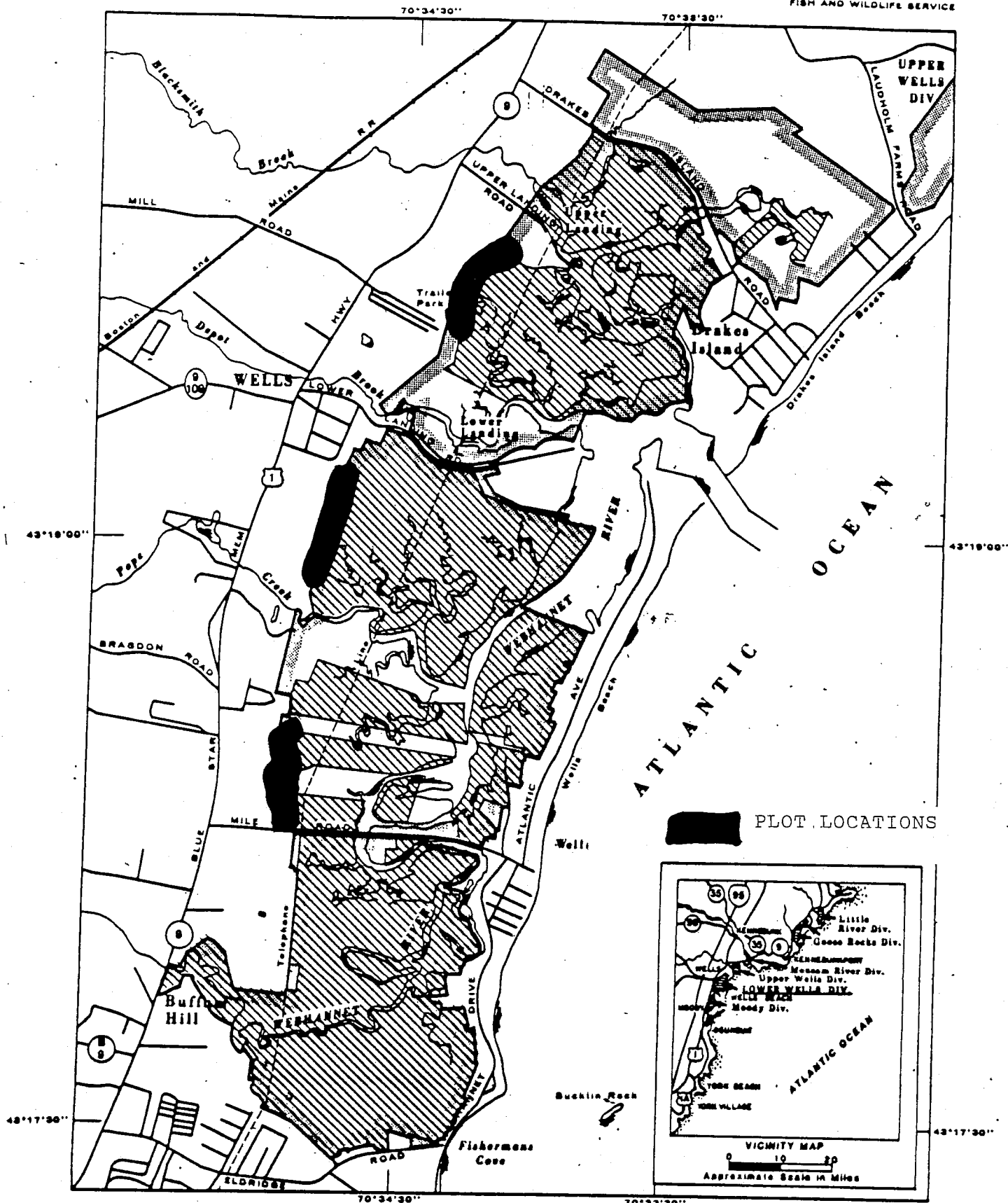
5R ME 770

UNITED STATES
DEPARTMENT OF THE INTERIOR

RACHEL CARSON NATIONAL WILDLIFE REFUGE

YORK COUNTY, MAINE

UPPER WELLS DIVISION
UNITED STATES
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G. AND U.S.F.A.W.S.

NEWTON CORNER, MASSACHUSETTS JUNE, 1988

MEAN
DECLINATION
1973

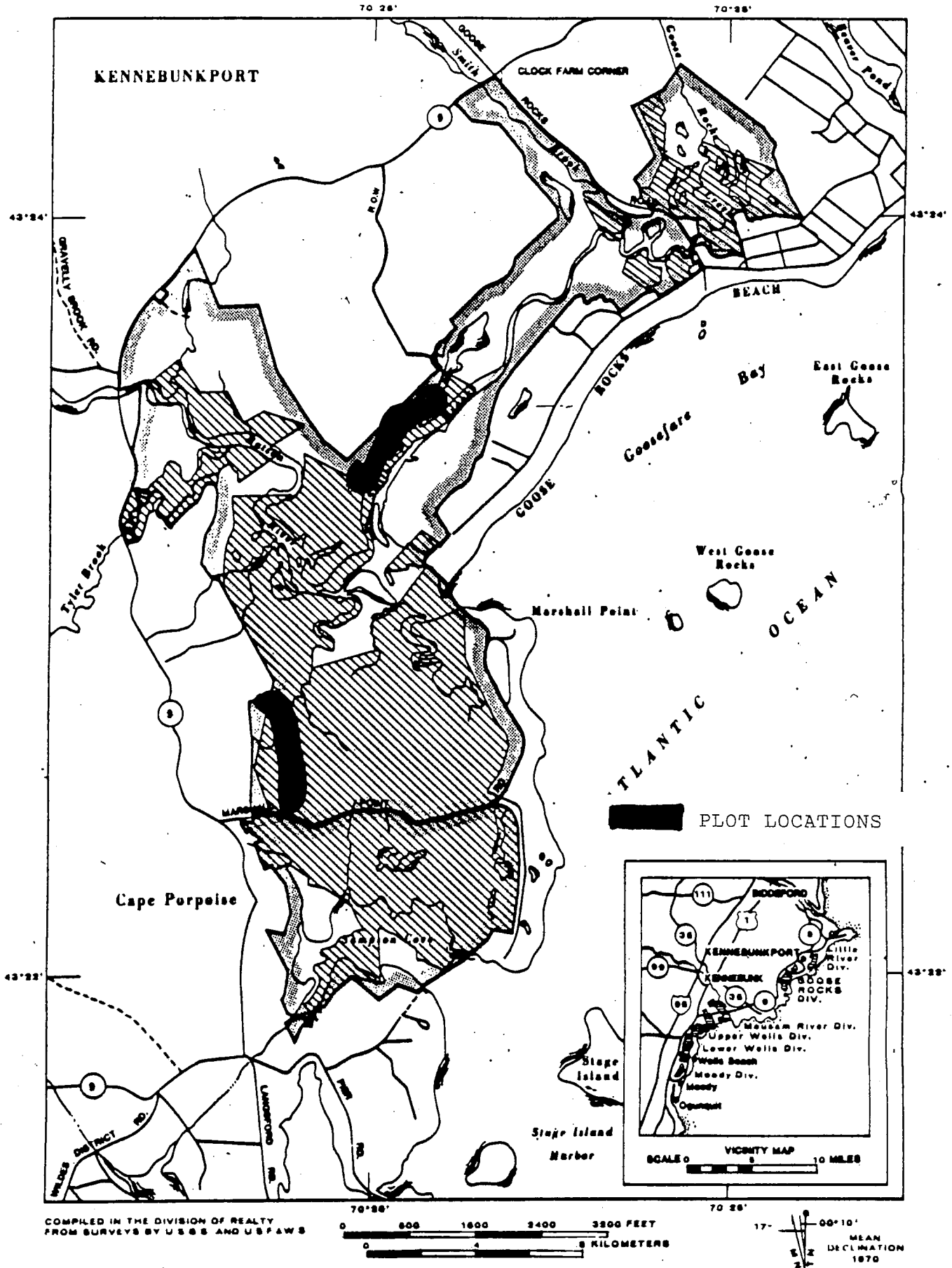
RACHEL CARSON NATIONAL WILDLIFE REFUGE

GOOSE ROCKS
DIVISION

UNITED STATES
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

UNITED STATES
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G.S. AND U.S.F.W.S.

0 600 1200 2400 3200 FEET
0 4 8 KILOMETERS

NEWTON CORNER, MASSACHUSETTS, JUNE, 1956

17° 00' 10" MEAN DECLINATION 1970

SR ME 770

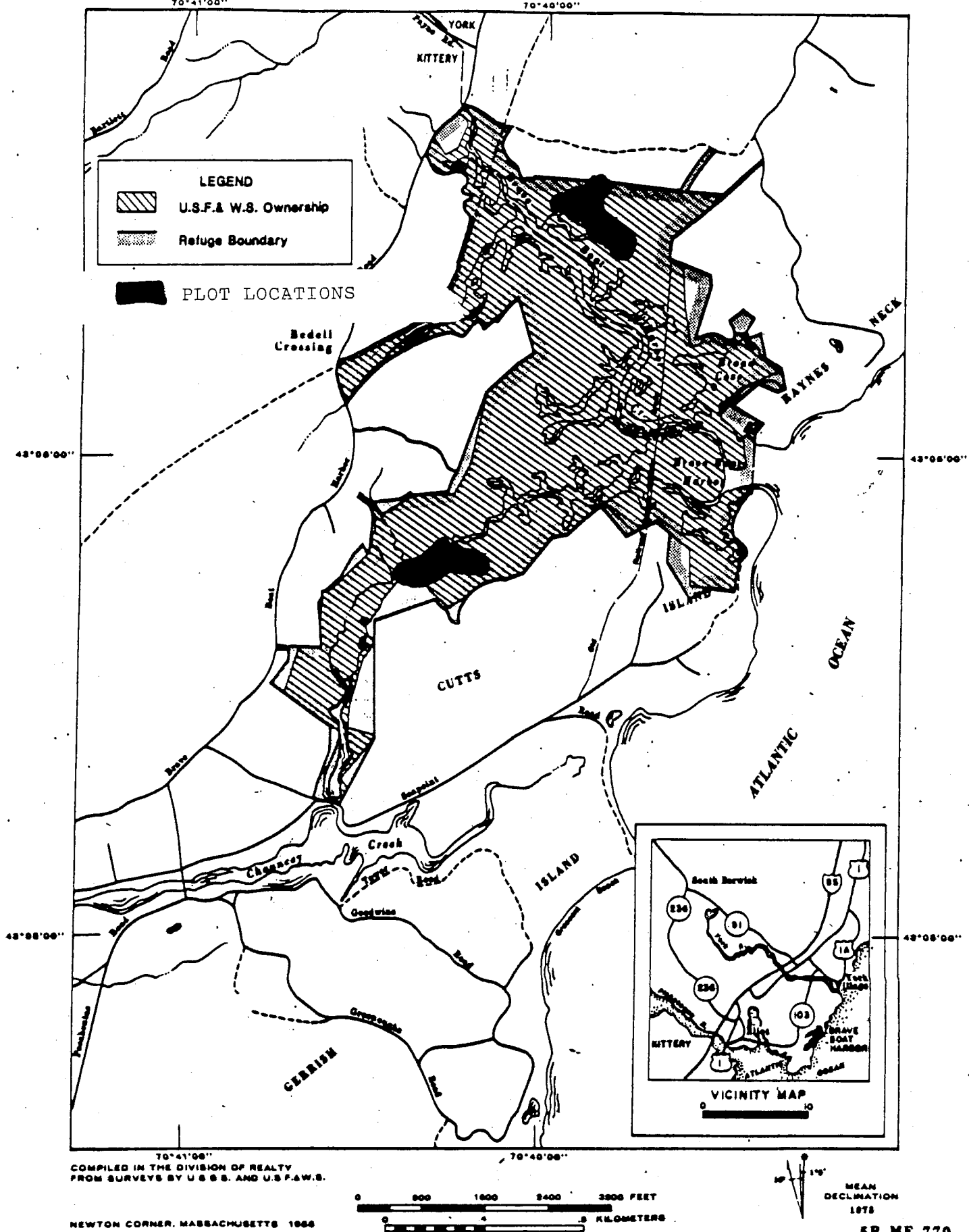
RACHEL CARSON NATIONAL WILDLIFE REFUGE

BRAVE BOAT
DIVISION

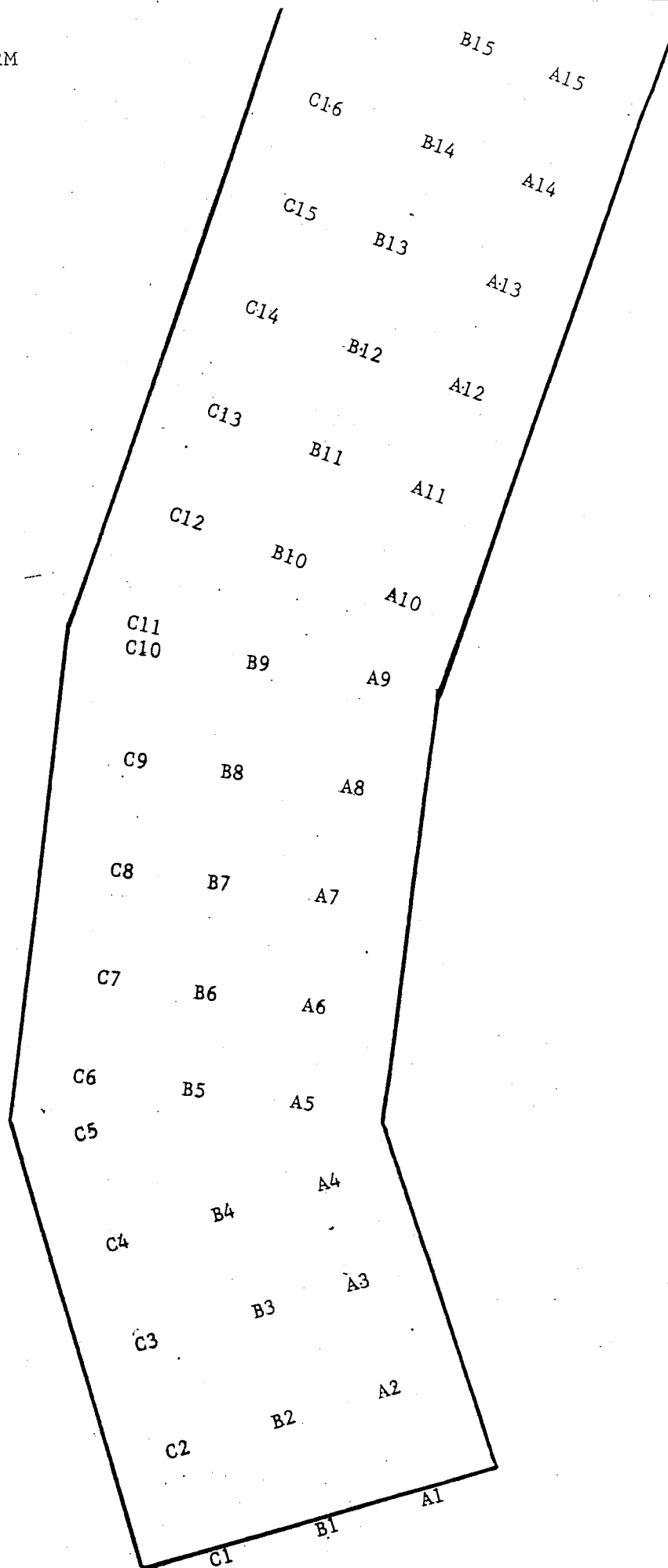
UNITED STATES
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

UNITED STATES
FISH AND WILDLIFE SERVICE

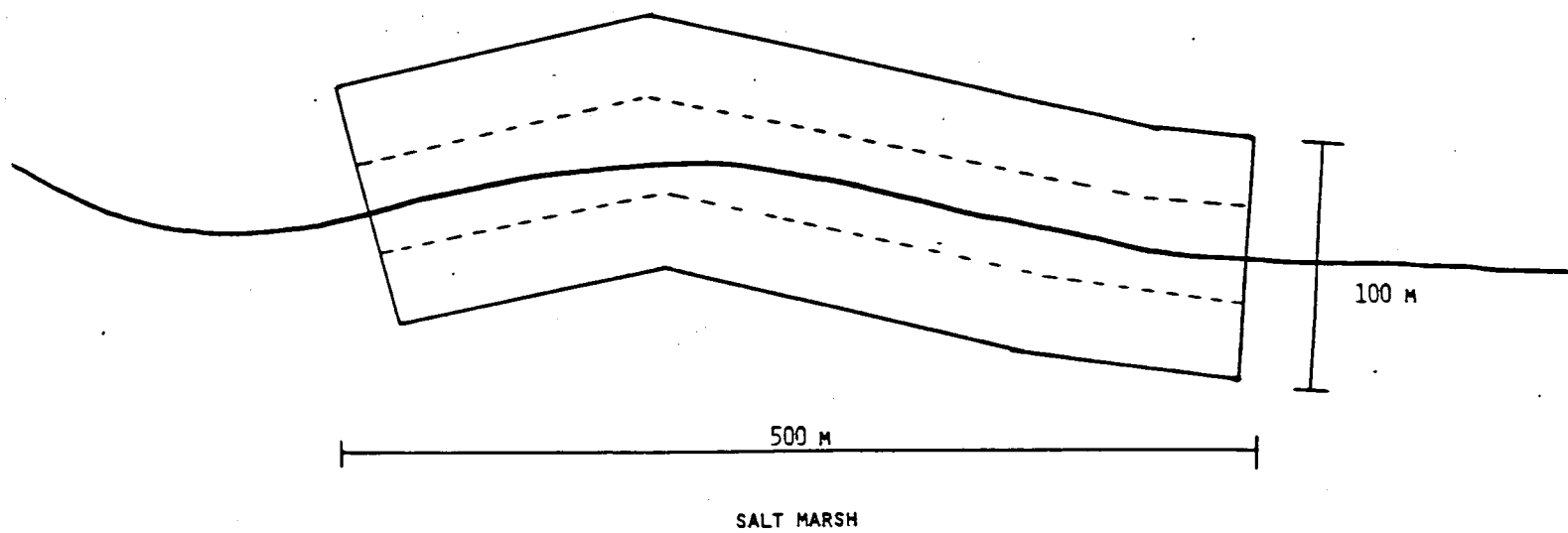


EXAMPLE FIELD DATA FORM



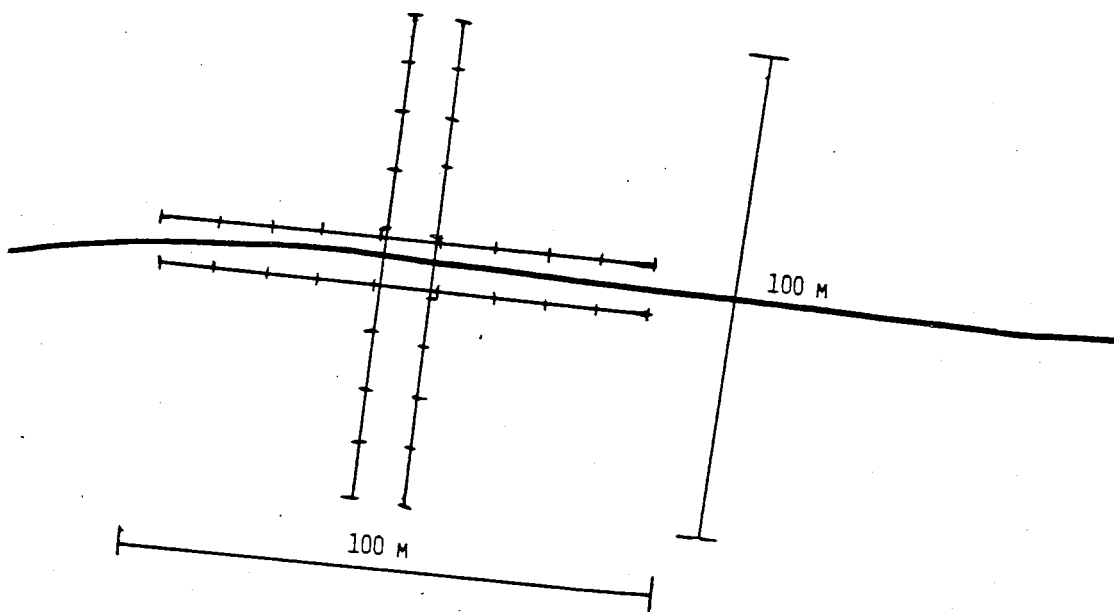
BREEDING BIRD PLOTS

UPLAND



SMALL MAMMAL PLOTS

UPLAND



SALT MARSH